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(54) **BELT DRIVE SYSTEM FOR SLIDING VEHICLE DOOR**

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(52) **U.S. Cl.** **49/360**; 49/358
(58) **Field of Search** 49/360, 324, 325, 49/358, 213; 474/148; 74/417

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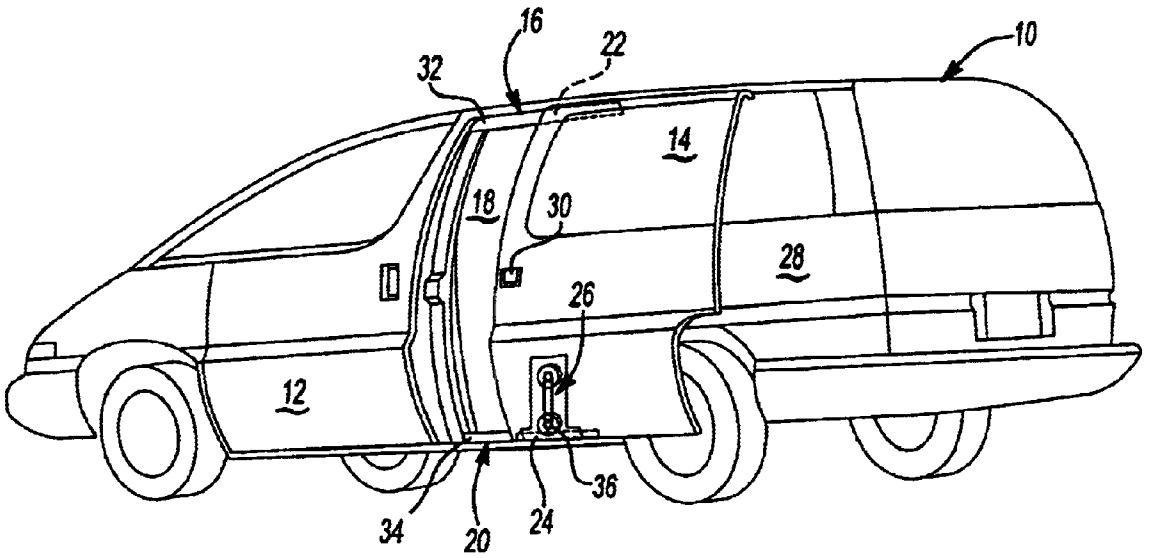
(57) **ABSTRACT**

A drive system drives a pulley along a curved track to open and close a sliding vehicle door. The pulley is pivotally mounted to the sliding door to permit the pulley to pivot when the pulley traverses the curved portion of the track. An electric motor drives the pulley through a drive belt. In operation, as the pulley pivots when it traverses the curved portion of the track, the drive belt twists. Torque transfer between the pulleys and the motor is maintained during twisting of the drive belt which thereby permits an uncomplicated yet effective system for driving the sliding door along the curved portion of track. Another drive system transmits torque through a drive shaft arrangement which rotates as the drive system traverses the curved portion of track.

14 Claims, 3 Drawing Sheets



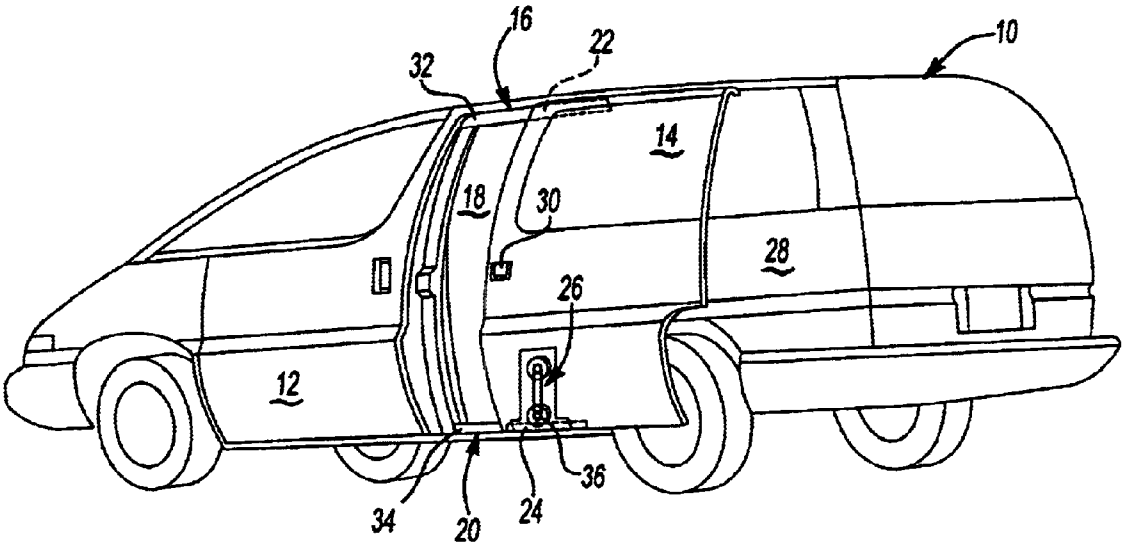


Fig-1

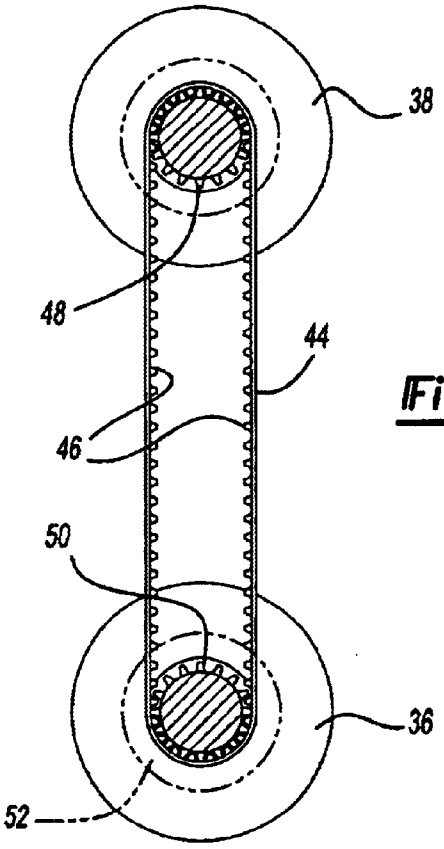


Fig-3

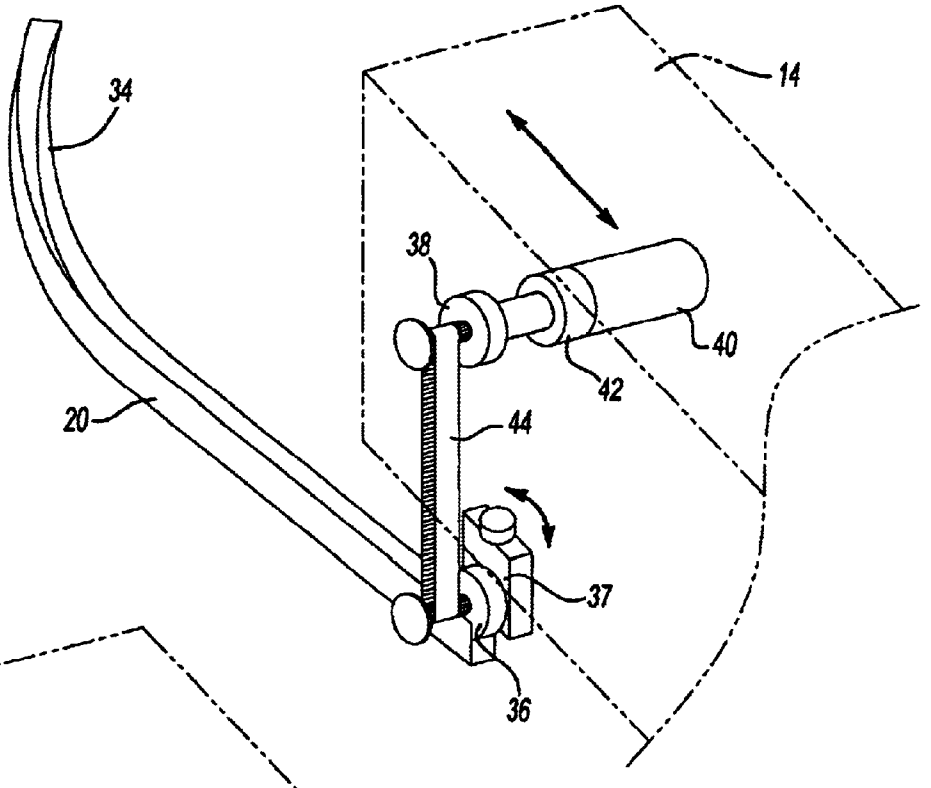


Fig-2

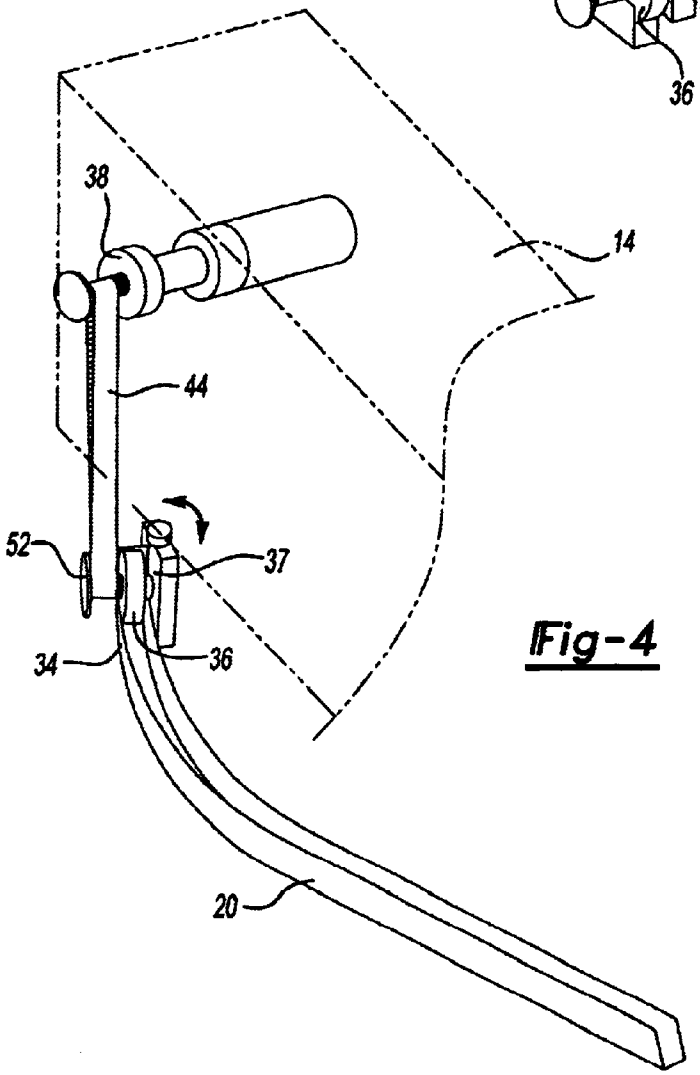


Fig-4

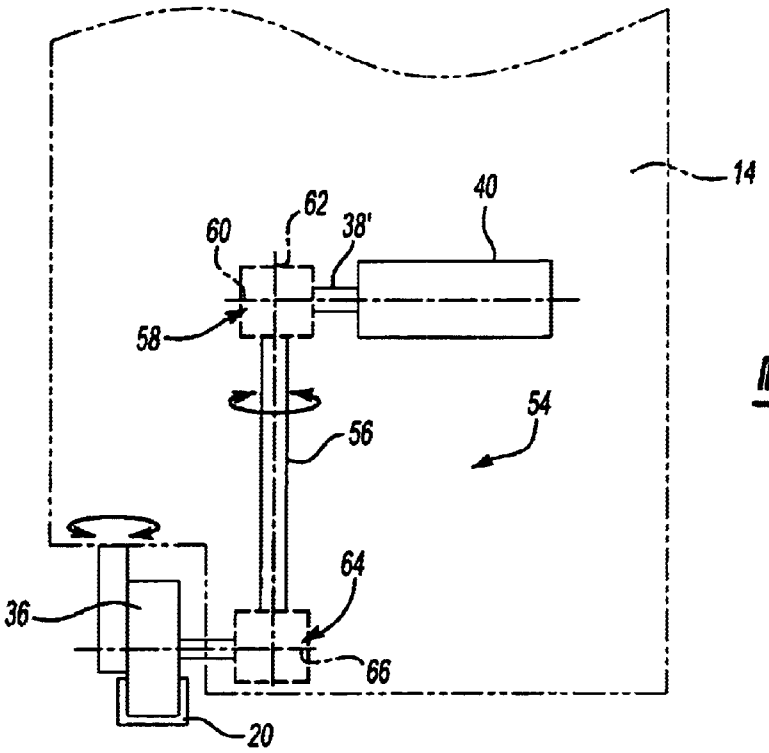


Fig-5

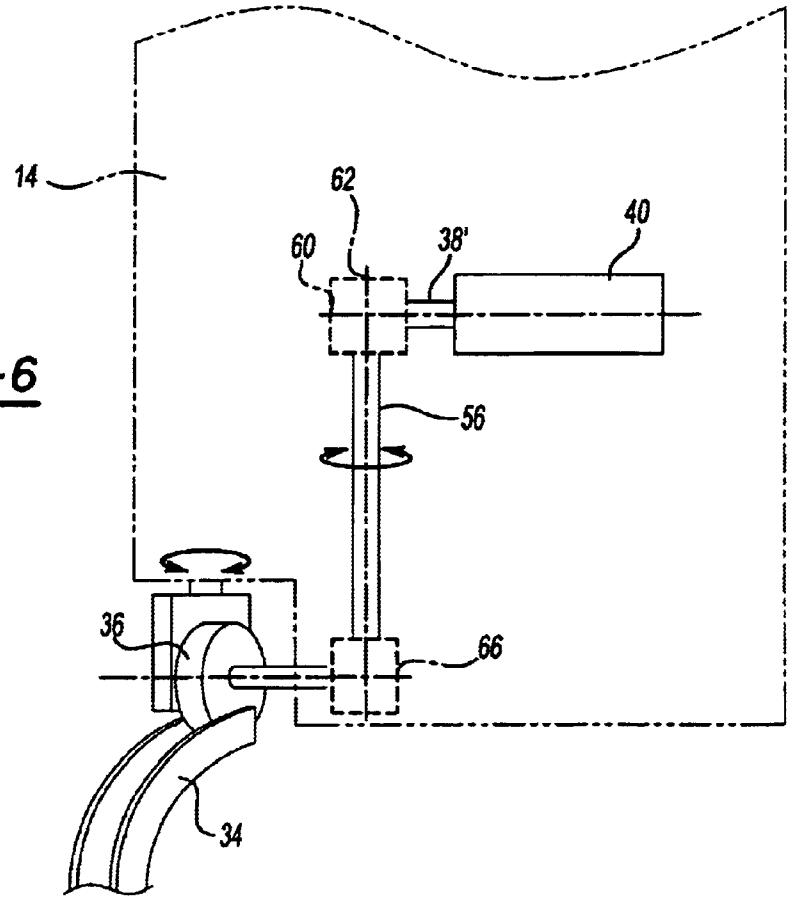


Fig-6

BELT DRIVE SYSTEM FOR SLIDING VEHICLE DOOR

BACKGROUND OF THE INVENTION

The present invention relates to a sliding vehicle door, and more particularly to a power operated drive system therefore.

In various types of vehicles, it is known to provide a sliding door where the door moves along a fixed path generally parallel to a side wall of the vehicle. Typically, the sliding door moves generally into the plane of the door opening during a portion of its respective final closing and initial opening movements. Movement into the plane of the door opening allows the sliding door to be flush with the side wall when fully closed. Movement out of the plane of the door opening during its initial opening movement allows the sliding door to be along side of, and parallel to, the side wall of the vehicle.

Guide rails or tracks are commonly attached to the top and bottom portions of the door opening to guide the sliding door. Typically, end portions of the various guide rails are curved inwardly with respect to the vehicle body to provide the out of plane movement. Roller assemblies are fastened to the respective upper and lower forward ends of the sliding door for movement along the guide rails to guide the door through its opening and closing movements.

Movement of the sliding door generally parallel to the side wall of the vehicle requires high displacement with low force to achieve the transitional movement since only frictional resistance and gravity resistances due to changes in grade must be overcome. Movement of the sliding door through the curved guide rail track requires low displacement with high force. As an elastomeric weather seal surrounding the door opening must be overcome and an unlatched striker must be engaged to lock the sliding door.

During manual operation, sliding van doors are typically moved with great momentum through the entire closing movement in order to ensure full weather strip compression and latch operation at the end of such movement. Powered operation, however, is relatively more complicated. To achieve effective operation, the drive system must drive the sliding door along the track in a reasonable time and provide enough force to overcome the elastomeric weather seal and the unlatched striker to assure proper closing of the sliding door. The drive system must also drive the sliding door through the change in direction of the curved guide rail. Although numerous effective powered drive systems are currently available, each is rather complicated and expensive to manufacture.

Accordingly, it is desirable to provide a powered drive system for a vehicle sliding door which is uncomplicated and cost effective.

SUMMARY OF THE INVENTION

The drive system according to the present invention drives a pulley along a curved track to open and close the sliding door. The pulley is pivotally mounted to the sliding door to permit the pulley to pivot during traverse of the curved portion of the track. A drive pulley transmits torque to the driven pulley through a drive belt.

In operation, as the driven pulley pivots during traverse of the curved portion of the track, the drive belt twists. Torque transfer between pulleys is maintained during twisting of the drive belt which thereby permits an uncomplicated yet effective system for driving the sliding door along the curved portion of track.

Another drive system according to the present invention transmits torque to the driven pulley through a drive shaft.

In operation, the drive shaft rotates about the shaft axis in concert with the driven pulley as the driven pulley traverses the curved portion of the track.

The present invention therefore provides a powered drive system for a vehicle sliding door which is uncomplicated and cost effective.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

FIG. **1** is a general perspective view a vehicle for use with the present invention;

FIG. **2** is a perspective view of one embodiment of a sliding door drive system of the present invention;

FIG. **3** is a schematic view of the drive system;

FIG. **4** is a schematic partially perspective view of a sliding door drive system of FIG. **2** in a second position;

FIG. **5** is a schematic partially perspective view of another sliding door drive system of the present invention; and

FIG. **6** is a schematic partially perspective view of the sliding door drive system of FIG. **5** in a second position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates a general perspective view of a vehicle **10** such as passenger van. Vehicle **10** includes a hinged front passenger door **12** and a sliding door **14**. The sliding door **14** is supported and guided by an upper track **16** adjacent opening **18** and a lower track **20** adjacent opening **18**. It should be understood that relative terms such as "upper" and "lower" are used with regard to the Figures for purposes of understanding and are not to be considered limiting.

An upper roller assembly **22** is attached to an upper forward corner of side door **14** and runs in upper track **16** that is at the top of the door opening. A lower roller assembly **24** is attached to the lower forward corner of side door **14** and runs in lower track **20** that is at the bottom of the side door opening. Operation of a sliding door for a van type vehicle is well known and need not be described in detail. Suffice it to say, drive system **26** drives the sliding door **14** between an open position and a closed position typically via a remote control or switch (not shown). The sliding door **14** moves inwardly (out of a plane parallel to a vehicle side wall **28**) to a closed position for closing and sealing the side opening **18**. A latch (illustrated schematically at **30**) is provided at the front of the sliding door **14** to latch the door **14** in the closed position.

Out of plane movement of sliding door **14** is achieved by curving the forward ends **32**, **34** of tracks **16**, **20** toward the vehicle interior. It should be understood that various mechanisms allow the rear of sliding door **14** to move in and out of plane with the side of the vehicle prior to opening and after fully closing. Drive system **26** drives a pulley **36** along track **20** to open and close the sliding door. It should be understood that various pulley to track engagements will benefit from the present invention. Pulley **36** may replace or be provided in addition to roller assemblies **22**,**24**. That is, the drive system **26** may be located in positions other than that shown. Furthermore, the drive system may alternatively or additionally be located on the vehicle **10** and drive the door **14**. Preferably, the pulley **36** is pivotally mounted to the sliding door **14** at a pivot **37** (FIG. **2**) to permit the pulley **36** to rotate during traverse of the curved portion **34** of track **20**.

Referring to FIG. **2**, pulley **36** is remotely rotated by a driven pulley **38**. Driven pulley **38** is preferably driven by an

electric motor **40**. The electric motor may directly drive pulley **38** or may do so through a gearbox (illustrated schematically at **42**). Drive pulley **38** and pulley **36** are within a common plane when pulley **36** is located upon the straight section of track **20**. With the exception of pulley **36**, drive system **26** is preferably contained within sliding door **14**.

Drive pulley **38** transmits torque to pulley **36** through a drive belt **44**. The drive belt **44** preferably includes a set of teeth **46** which engage corresponding teeth sets **48**, **50** extending from pulleys **36** and **38** (FIG. **3**). Slippage during torque transfer between pulleys **36**, **38** is thereby minimized.

In operation, as the pulley **36** pivots during traverse of the curved portion **34** of track **20**, the drive belt **44** twists (FIG. **4**). That is, the pulleys **36**, **38** are not in the same plane. Preferably, a flange **52** extends from pulley **36** to minimize axial movement of drive belt **44**. Torque transfer between pulleys **36**, **38** is maintained during twisting of the drive belt **44** which thereby permits an uncomplicated yet effective system for driving the sliding door **14** along the curved portion **34** of track **20**.

Referring to FIG. **5**, another drive system **54** is disclosed. A drive shaft **38'** transmits torque to pulley **36** through a drive shaft **56**. The drive shaft **38'** is driven by an electric motor **40** as described above. A gear set (illustrated schematically at **58**) driven by the drive shaft **38'** transmits rotation from electric motor **40** about axis **60** to rotate drive shaft **56** about shaft axis **62**. A second gear set (illustrated schematically at **64**) converts rotation of drive shaft **56** about shaft axis **62** to rotation of pulley **36** about axis **66** (FIG. **6**). Axis **60** and axis **66** are within a common plane unless pulley **36** is pivoted during traverse of the curved portion **34** of track **20**.

In operation, as the pulley **36** rotates during traverse of the curved portion **34** of track **20**, the drive shaft **56** rotates therewith as the drive shaft **56** is located within a common plane but perpendicular to track **20**. That is, drive shaft **56** rotates about shaft axis **62** in concert with pulley **36** during traverse of the curved portion **34** of track **20**.

The foregoing description is exemplary rather than defined by the limitations within. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A powered drive system for a sliding vehicle door comprising:

an electric motor;

a first pulley driven by said electric motor;

a second pulley drivable along a guide track comprising a curved track portion; and

a drive mechanism between said first pulley and said second pulley to transmit torque from said first pulley to said second pulley, said drive mechanism at least partially twisting only as said second pulley pivots to traverse said curved track portion.

2. The powered drive system as recited in claim **1**, wherein said second pulley is adapted to be pivotally mounted to the sliding vehicle door.

3. The powered drive system as recited in claim **1**, wherein said guide track is adapted to be fixed to a vehicle including the sliding vehicle door.

4. The powered drive system as recited in claim **1**, wherein said drive mechanism comprises a drive belt.

5. The powered drive system as recited in claim **4**, wherein said first pulley, said second pulley and said drive belt are driven within a common plane, said drive belt only twisting out of said common plane in response to said second pulley traversing said curved track portion.

6. The powered drive system as recited in claim **4**, further comprising a guide flange extending from said second pulley to retain said drive belt.

7. The powered drive system as recited in claim **4**, wherein said drive belt is oriented generally perpendicular to said guide track.

8. A powered drive system for a sliding vehicle door comprising:

an electric motor;

a first pulley driven by said electric motor;

a second pulley drivable along a guide track comprising a curved track portion; and

a drive belt between said first pulley and said second pulley to transmit torque from said first pulley to said second pulley, said drive belt at least partially twisting only as said second pulley traverses said curved track portion.

9. The powered drive system as recited in claim **8**, wherein said second pulley is adapted to be pivotally mounted to the sliding vehicle door, said second pulley pivoting as said second pulley traverses said curved track portion and said guide track adapted to be fixed to a vehicle which includes the sliding vehicle door.

10. The powered drive system as recited in claim **8**, wherein said drive belt includes a set of teeth which engage corresponding sets of teeth extending from said first pulley and said second pulley.

11. The powered drive system as recited in claim **8**, further comprising a guide flange extending from said second pulley to retain said drive belt.

12. The powered drive system as recited in claim **8**, wherein said first pulley, said second pulley and said drive belt are driven within a common plane, said drive belt twisting out of said common plane in response to said second pulley traversing said curved track portion.

13. The powered drive system as recited in claim **8**, wherein said second pulley twists said drive belt in response to said second pulley traversing said curved track portion.

14. A powered drive system for a sliding vehicle door comprising:

an electric motor;

a first pulley driven by said electric motor;

a second pulley drivable along a guide track comprising a curved track portion; and

a drive mechanism between said first pulley and said second pulley to transmit torque from said first pulley to said second pulley, said drive mechanism at least partially twisting only as said second pulley pivots to traverse said curved track portion, said drive mechanism includes a drive belt wherein said first pulley, said second pulley and said drive belt are driven within a common plane, said drive belt twisting out of said common plane in response to said second pulley traversing said curved track portion.

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